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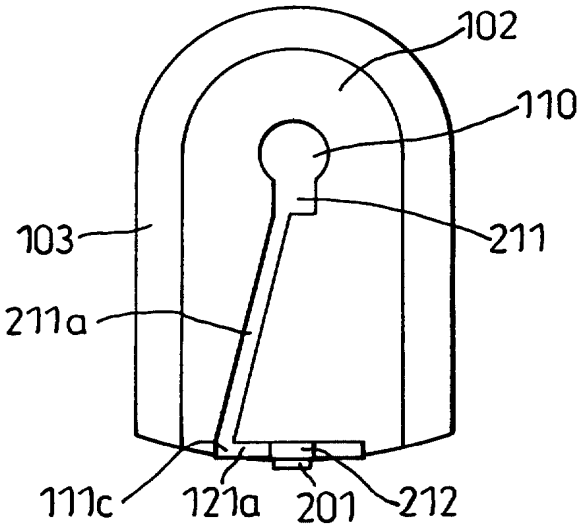

(57) Abstract: The present invention relates to improvements in or relating to nozzles. In particular, the present invention relates to a novel form of nozzle arrangement which is adapted to be fitted to an outlet of a fluid supply and generate a spray of fluid dispensed through said outlet. The nozzle arrangements of the present invention comprise an inlet (110) through which fluid may access the nozzle arrangement from the fluid supply during use, a fluid flow passageway (111) which connects the inlet (110) to a swirl chamber (112) such that fluid entering the nozzle arrangement during use is directed along said fluid flow passageway and into said swirl chamber and an outlet (113) formed in the swirl chamber. The outlet may be in the form of at least two outlet orifices (401) provided in the wall of the swirl chamber or an elongate slit (202). It has been found that the aforementioned forms of outlet dramatically reduce or atomise the droplets ejected from the swirl chamber during use and, furthermore, that such arrangements enable small aerosol droplets to be pressures. The present invention also relates to nozzle outlet inserts that are adapted to be fitted to a nozzle arrangement comprising an inlet and a fluid flow passageway and form the outlet thereof. The inserts of the present invention comprise a swirl chamber and one of the aforementioned forms of outlet.

WO 03/045573 A1

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NOZZLES

The present invention relates to improvements in or relating to nozzles.

Nozzles are widely used in a range of different applications to generate sprays (typically known as aerosol sprays) from fluids. In particular, nozzles are commonly fitted to pressurised fluid-filled containers, such as a so-called "aerosol canister", to facilitate the actuation of the release of the fluid stored therein in the form of a spray or mist. A large number of commercially-available products are presented to consumers in this form, including, for example, antiperspirant sprays, de-odorant sprays, perfumes, air fresheners, antiseptics, paints, insecticides, polish, hair care products, pharmaceuticals, water and lubricants. In addition, so-called pump or trigger nozzle devices, i.e. devices where the release of product from a non-pressurised container is actuated by the operation of a manually-operable pump or trigger which forms part of the nozzle arrangement, are also widely used to generate sprays from fluids stored in non-pressurised containers. Examples of products that are typically provided with pump or trigger nozzle devices include creams/lotions, food products, insecticides, as well as various garden and household sprays.

During use, an aerosol spray is formed by forcing the fluid through the nozzle under pressure. The nozzle is configured to cause the fluid stream passing through to break up or "atomise" into numerous droplets, which are then ejected from the nozzle in the form of a spray or mist.

The optimum size of the droplets required in an aerosol spray depends primarily on the product concerned and the application for which it is intended to be used. For example, a pharmaceutical spray containing a drug which is intended to be inhaled by a patient (e.g. an asthmatic patient) usually requires droplets having small average diameters, typically up to 50 microns, so that the

aerosol droplets are sufficiently small to penetrate deep into the lungs. In contrast, a polish spray preferably comprises aerosol droplets with larger diameters to reduce the extent of inhalation, particularly if the spray is toxic, and to promote the impaction of the aerosol droplets on the surface that is to be polished.

Currently available nozzle arrangements can be used to produce sprays containing aerosol droplets within virtually any desired size range. The size of the aerosol droplets produced is dictated by a number of factors including the dimensions of the outlet orifice and the pressure with which the fluid is forced through the nozzle. However, a problem can arise if it is desired to produce an aerosol spray that comprises small droplets at a low pressure. The generation of a spray at a low pressure is becoming particularly desirable because it enables low pressure nozzle devices, such as the manually-operable pump or trigger sprays, to be used and, in the case of the pressurised fluid-filled containers, it enables the quantity of propellant present in the container to be reduced, or alternative propellants which typically provide lower pressures, such as compressed gas, to be used. The desire to reduce the level of propellant used in aerosol canisters is a topical issue at the moment and is likely to become more important in the future due to legislation planned in certain countries, which proposes to impose restrictions on the amount of propellant that can be used in hand-held aerosol canisters. Accordingly, there is a requirement for a nozzle arrangement that is capable of producing an aerosol spray composed of suitably small droplets at low pressures.

A further problem with known pressurised aerosol canisters fitted with conventional nozzle arrangements is that the size of the aerosol droplets generated tends to increase during the lifetime of the aerosol canister, particularly towards the end of the canisters life when the level of propellant present therein is depleted and hence, the pressure within the canister reduces.

It is this reduction in pressure that causes the observed increase in the size of the aerosol droplets generated. As the quality of the spray is compromised as the aerosol droplet size increases, a demand exists for an alternative nozzle arrangement that is capable of generating sufficiently small aerosol droplets at lower pressures.

Known nozzle arrangements typically comprise an inlet through which fluid can enter the nozzle from a fluid supply, an outlet through which fluid is ejected from the nozzle, and a fluid flow passageway through which fluid flows from the inlet of the nozzle to the outlet during use. Examples of such nozzle arrangements are described in WO 01/89958 and W0 97/31841, the entire contents of which are incorporated herein by reference. One approach to reduce the size of the aerosol droplets ejected from such nozzle arrangements during use involves the provision of a so-called swirl chamber in the fluid flow passageway. The swirl chamber is usually positioned at the outlet end of the fluid flow passageway and the outlet is a single hole formed in the chamber so that fluid enters the swirl chamber immediately prior to ejection through the outlet orifice. The swirl chamber induces rotational flow into the fluid stream passing through the nozzle prior to the ejection of the fluid through the outlet. This rotational flow induced in the fluid stream is understood to effectively create a vortex about the outlet orifice of the nozzle, which causes the fluid to further break up or 'atomise' as it is ejected through the outlet orifice in the form of a spray. The result is typically the formation of a fine hollow cone spray. However, it is still not possible to produce sufficiently small aerosol droplets for certain applications with such nozzle arrangements, particularly when the spray is generated at a low pressure.

An object of the present invention is, therefore, to provide an improved nozzle arrangement which is capable of producing suitably small droplets at low pressures, i.e. as occurs in a pressurised container when the level of

propellant is reduced or depleted during use or when a relatively low-pressure propellant system, such as compressed gas, is used, or a typically low-pressure generating nozzle device, such as a pump or trigger nozzle device, is used in conjunction with a non-pressurised container.

According to a first aspect of the present invention there is provided a nozzle arrangement adapted to be fitted to an outlet of a fluid supply and generate a spray of fluid dispensed through said outlet, said nozzle arrangement comprising an inlet through which fluid may access the nozzle arrangement from the from the fluid supply during use, a fluid flow passageway which connects said inlet to a swirl chamber such that fluid entering the nozzle arrangement during use is directed along said fluid flow passageway and into said swirl chamber, said swirl chamber being configured to induce rotational flow in the fluid passing through the nozzle arrangement, wherein said swirl chamber comprises at least two outlet orifices through which fluid can be ejected from the swirl chamber during use.

Known nozzles comprise a swirl chamber provided with a single outlet orifice. The size of the droplets present in the aerosol spray produced by these known nozzle arrangements can be reduced by reducing the dimensions of the outlet orifice. However, reducing the size of the outlet orifice also impedes the flow of fluid from the nozzle and hence, results in a decrease in the total volume of fluid ejected from the nozzle during any given time period.

In contrast, it has been found that the nozzle arrangements of the present invention can generate sprays in which the average size of the aerosol droplets generated is significantly reduced compared with the size of the aerosol droplets in sprays generated by these known nozzle arrangements. Furthermore, the suitably small droplets can also be prepared at reduced pressures, or even when the pressure gradually reduces over time as, for

example, the propellant becomes depleted during use. The provision of several outlet orifices also enables the required flow through the nozzle arrangement to be maintained and thus, avoids any reduction in the volume of fluid dispensed such as that observed with the known devices when the size of the single outlet orifice is reduced.

It has also been found that each outlet orifice present in the nozzle arrangements of the present invention produces a hollow cone spray which comprises smaller droplets than those produced at the single outlet of the known nozzle arrangements under equivalent conditions. The provision of multiple outlet orifices through which the fluid can be ejected from the swirl chamber is believed to generate multiple vortices within the swirl chamber surrounding each individual outlet orifice and this effect is believed to contribute to the further reduction in the size of the aerosol droplets observed with these nozzle arrangements. In addition, the nozzles of the present invention have also been found to produce a fuller cone spray when compared with the sprays produced by the known devices. The reason for this effect is understood to be due to the fact that each of the multiple outlet orifices is typically smaller than the single outlet orifice of the known devices and the angle of the spray cone produced at each orifice is also smaller which enables the sprays to merge to form a fuller spray cone. The reason for this is also believed to be partly due to the reduced rotational forces induced in the swirl chamber at each individual outlet orifice, which is less than that which occurs at the single outlet orifice of known arrangements.

To illustrate the reduction in the aerosol droplet size obtained using the nozzle arrangement of the present invention, it has been found that a known nozzle arrangement which utilises compressed gas as a propellant and which comprises a swirl chamber positioned adjacent to a single outlet orifice produces aerosol droplets with an average diameter of over 100 microns,

whereas droplets with an average diameter of approximately 50 - 65 microns where obtained using a nozzle arrangement of the present invention under identical conditions.

Similarly, with other devices, reductions in the size of the droplets from 60 microns with the known nozzle arrangements to 35 microns with nozzle arrangements of the present invention have also been observed under identical conditions.

Preferably, the nozzle arrangement comprises an actuator, the operation of which actuates the release of the fluid from the fluid supply. In the case of a pump or trigger nozzle arrangement, the actuator is the pump or trigger, which, upon operation, generates the pressure to cause the contents of the fluid supply to be dispensed through the nozzle. In the case of a nozzle fitted to a pressurised aerosol canister, the actuator is a portion of the nozzle arrangement that can be depressed or otherwise operated so that it engages with and opens the outlet valve of the aerosol canister, thereby actuating the release of the contents stored therein through the nozzle arrangement.

In most cases the fluid supply will be a pressurised fluid-filled container. Preferably, the fluid supply is a hand-held aerosol canister and the nozzle arrangement is adapted to be fitted to the canister so as to enable the engagement of the actuator with the outlet valve of the canister, thereby enabling the release of the contents of the canister to be facilitated. Alternatively, the fluid supply may be a non-pressurised container having a pump or trigger nozzle device fitted to its outlet to actuate the release of the contents stored in the container.

The swirl chamber may be any suitable swirl chamber known in the art that is capable of inducing rotational flow in the fluid stream passing through the nozzle arrangement. Conventionally, swirl chambers are circular in cross-

section and the fluid enters the chamber via one or more channels which direct the fluid flow towards the circular wall of the swirl chamber so as to cause the fluid to flow within the chamber in a rotational or "swirling" manner. Such swirl chambers are generally preferred in the nozzle arrangements of the present invention.

The fluid passing through the nozzle may enter the swirl chamber through either a single channel or through multiple channels. Preferably, there are between one and six channels through which fluid may enter the swirl chamber. In embodiments where there are two, three, four, five or six separate channels, each channels may be connected to a branch of a single fluid flow passageway or to a completely separate fluid flow passageway which connects the channel directly to the inlet.

Preferably, the at least two outlet orifices are arranged so that the sprays generated at each separate outlet orifice merge to form a single aerosol spray cone.

The nozzle arrangements of the present invention also preferably comprise between two and eight outlet orifices. Most preferably, the nozzle arrangement comprises two, three, four or five outlet orifices.

The outlet orifices of the nozzle arrangements of the present invention may be arranged in any suitable configuration. In some embodiments of the invention, each outlet orifice may be arranged in a substantially parallel relationship, i.e. the outlet orifices may be arranged so that the bore defined by each individual orifice extend in parallel so that any fluid passing through the orifices does so in a substantially parallel direction. For example, the outlet orifices could be arranged so that the central longitudinal axis of the bore defined by each orifice extends in a direction substantially parallel to the central longitudinal axis of the swirl chamber so that, during use, fluid droplets ejected

from the swirl chamber pass through each outlet orifice in a direction that is substantially parallel to the central longitudinal axis of the swirl chamber. For the avoidance of doubt, the expression "central longitudinal axis of the swirl chamber" is used herein to denote a central axis of the swirl chamber which extends in a direction towards the outlet orifices. For example, if the swirl chamber is a cylindrical swirl chamber (as would usually be the case), then the central longitudinal axis of the cylindrical chamber will be the "central longitudinal axis of the swirl chamber".

Preferably, however, the outlet orifices may be arranged in a divergent relationship, i.e. the outlet orifices may be arranged so that the bore defined by each individual orifice is disposed in a divergent angle with respect to at least a proportion of the other outlet orifices present such that, during use, fluid passing through an outlet orifice does so in a direction that is divergent with respect to at least a proportion of the other outlet orifices. For example, the outlet orifices may be arranged in a divergent relationship so that each the central axis of the bore defined by each outlet orifice is disposed at a divergent angle with respect to the central longitudinal axis of the swirl chamber, thereby, during use, forcing fluid droplets passing though an outlet orifice to be projected from the nozzle at an angle which is divergent with respect to the central longitudinal axis of the swirl chamber. Furthermore, it is preferred that the bore defined by each orifice extends in a direction which diverges from central longitudinal axis of the swirl chamber at an angle within the range of 3 to 60°, with angles within the range of 8 to 23° being most preferred. In addition, it is preferred that the bores of adjacent outlet orifices diverge with respect to one another through an angle of between 3 to 60°, with angles of 15° or 16° being especially preferred. It has been found that this “divergent” arrangement of the outlet orifices forms a continuous rectangular or oval spray cone with much finer droplets than those that could be produced using the

known single outlet orifice arrangement. In addition, when each outlet orifice is arranged so that the central longitudinal axes are disposed in a parallel, or even convergent, relationship with respect to one another or the central longitudinal axis of the swirl chamber, the droplets of the spray ejected through each orifice tend to coalesce to form larger droplets, whereas the divergent arrangement of the outlet orifices has been found to reduce the extent of coalescence. Furthermore, less coalescence is observed as the angle of divergence between respective adjacent orifices is increased.

The "divergent" outlet orifices can be arranged in any configuration at the fluid outlet, for example in a circular, triangular or oval relationship, although it is especially preferred that the divergent outlets are arranged in a horizontal line across the central axis of the swirl chamber. An example of this arrangement of the fluid outlet orifices is described in more detail herein in reference to Figure 5 of the accompanying drawings.

The bore defined by each outlet orifice may be of any cross-sectional shape, for example circular, semi-circular, rectangular, square etc., or of uniform or varying cross-sectional area throughout its length. In addition, the internal surface of the bore may have a roughened or smooth surface. In some embodiments of the invention, the outlet orifice could be shaped to induce further rotation by incorporating, for example, a screw thread or rifle barrel design. Such embodiments are suited to the two-part construction described further below.

The outlet orifices may also be tapered. Preferably the bore of the orifice is wider at its opening with the swirl chamber and tapers towards the external surface of the nozzle arrangement.

There may also be a fine curved pathway leading to each spray orifice inside the swirl chamber to further increase the amount of rotation induced in the fluid stream passing through the outlet orifices.

The nozzle arrangements of the present invention are preferably formed from moulded plastic.

The nozzle arrangements of the present invention are preferably formed from at least two parts and these parts may be interconnected and movable apart to enable cleaning of the nozzle arrangement to take place. Most preferably, the nozzle arrangement is formed of two parts interconnected by a hinge so as to enable the respective parts to be conveniently moved towards or away from each other to enable cleaning to be carried out. In some embodiments, however, the two halves may also be joined together permanently by ultrasonic welding or an equivalent technique to form a single integral nozzle arrangement.

It is also preferable each part of the nozzle arrangement comprises an abutment surface which contact each other when the parts are brought together. The abutment surfaces may be provided with grooves and/or recesses formed thereon which, when the parts are brought into contact, define therebetween the outlet orifices, swirl chamber, fluid flow passageway and the inlet of the nozzle arrangement. Nozzle arrangements of this construction are described further in WO 01/89958 and W0 97/31841, the entire contents of which are incorporated herein by reference. Preferably, a seal is provided between the abutment surfaces, which, when the abutment surfaces are brought into contact, prevent fluid passing through the nozzle arrangement from leaking out.

An advantage of manufacturing the nozzle arrangement from at least two-parts is that it can be manufactured very cheaply and is also much more practical for forming the moulded outlet orifices of the nozzle.

It is especially preferred that the outlet orifices are formed by forming a groove with a semicircular or concave profile in just one of the two parts of the nozzle so that, when the two parts are brought together, an outlet orifice defining a bore with a semicircular cross-sectional profile is formed. This obviates the requirement to precisely align two respective grooves formed on opposing abutment surfaces to form an outlet orifice defining a bore with a circular cross-sectional profile, for example.

The external surface of the nozzle arrangement may also be shaped to form a dish-shaped or cone-shaped recess around the opening of the outlet orifices. The dish-shaped recess may be in the form of a "flat bottomed dish" with the outlet orifice positioned within the "flat bottom" portion of the dish. Alternatively, the dish-shaped recess may have continuously curving walls (i.e. with no flat bottom present) with the external outlet orifice opening positioned centrally within the recess. The use of such recesses has been found to enhance the generation of an even cone spray.

According to the second aspect of the present invention there is provided a nozzle arrangement adapted to be fitted to an outlet of a fluid supply and generate a spray of fluid dispensed through said outlet, said nozzle arrangement comprising an inlet through which fluid may access the nozzle arrangement from the from the fluid supply during use, a fluid flow passageway which connects said inlet to a swirl chamber such that fluid entering the nozzle arrangement during use is directed along said fluid flow passageway and into said swirl chamber, said swirl chamber being configured to induce rotational flow in the fluid passing through the nozzle arrangement, wherein said fluid outlet comprises a fluid outlet orifice in the form of an elongate slit opening.

As previously mentioned, known outlet nozzle arrangements comprise a swirl chamber provided with a single outlet orifice. The single outlet orifice is

a centrally positioned with respect to the swirl chamber and defines a bore having a circular cross-section. However, in contrast to these known nozzle arrangements, it has surprisingly been found that the nozzle arrangements according to the second aspect of the present invention can produce much finer sprays comprising smaller droplets than those that can be generated by the known nozzle devices. To illustrate this, it has been demonstrated that substituting the single outlet orifice of the known nozzle arrangements for an elongate slit outlet orifice of the second aspect of the present invention results in a reduction of the average droplet size of the spray produced from approximately 100 microns to approximately 53 microns.

The slit may be up to 200 microns in width for certain applications. Preferably, however, the slit is up to 100 microns in width, with a width dimension within the range of 20 to 60 microns being most preferred. The slit is preferably between 300 to 1300 microns in length.

In most embodiments only one elongate slit orifice will be present, although two, three, four or more slits could be present if so desired.

The elongate slit orifice may be positioned at any angle across the swirl chamber, for example horizontal, vertical or diagonal. Preferably, the slit extends across the central longitudinal axis of swirl chamber, although in some embodiments of the invention it may be off-set with respect to the central axis of the swirl chamber.

As discussed above, the external surface of the nozzle arrangement may be shaped to form a dish-shaped recess around the external opening of the slit. The provision of a dish-shaped recess around the external outlet of the slit has been found to produce an even cone spray rather than a spray in the form of a "fan" which is formed when no recess is provided. In certain embodiments, the recess may be a "flat bottomed dish" with the slit provided in the flat bottom

portion of the recess as previously described. In certain alternative embodiments of the invention, however, the dish-shaped recess has continually curving walls (i.e. no flat bottom portion is present) and the external opening of the slit is positioned within the recess and has a correspondingly curved profile.

For certain nozzles, particularly industrial nozzles, it is known to provide the swirl chamber, together with the outlet orifice formed therein, as a separate insert to be fitted into the nozzle arrangement. Hence, according to the third aspect of the present invention there is provided a nozzle outlet insert configured to be attached to, and form the outlet of, a nozzle arrangement comprising an inlet and a fluid flow passageway, said fluid flow passageway being adapted to connect said inlet to said insert such that, during use, fluid passing through said nozzle arrangement is directed from the inlet towards said insert along said fluid flow passageway, wherein said nozzle outlet insert comprises a swirl chamber having at least two outlet orifices formed herein, as hereinbefore defined.

According to a fourth aspect of the present invention there is provided a nozzle outlet insert configured to be attached to, and form the outlet of, a nozzle arrangement comprising an inlet and a fluid flow passageway, said fluid flow passage being adapted to connect said inlet to said insert such that, during use, fluid passing through said nozzle arrangement is directed from the inlet towards said insert along said fluid flow passageway, wherein said nozzle outlet comprises a swirl chamber having an outlet orifice in the form of an elongate slit as hereinbefore defined.

The nozzle outlet inserts of the third and fourth aspects of the invention are adapted to be fitted to a standard nozzle arrangement and form the fluid outlet thereof through which fluid is ejected to form a spray.

Preferably, the nozzle outlets of the third and fourth aspect of the present invention additionally comprise an engagement means by which the insert can be secured into position on the nozzle arrangement.

The nozzle outlets can be provided in various shapes and configurations to enable the insert to be fitted to virtually any nozzle arrangement.

It will be appreciated that the swirl chamber of the insert will be usually be open at one end, and a closed internal swirl chamber is formed in the final nozzle arrangement when the insert is fixed into position.

Preferably, the nozzle outlet inserts of the third and fourth aspects of the invention are also prepared from two separate parts with the outlet orifices or slit being formed as grooves in the contacting surface either one or both of the parts so that the final outlet orifice is formed when the two parts are connected together.

The nozzles of the present invention may be used in a wide range of applications and with a wide range of spray-forming devices, including industrial spray devices, trigger sprays, pump sprays and pressured containers which utilise either a liquid-based propellant or a compressed gas propellant. A particular advantage of the nozzle arrangements of the present invention is that small spray droplets can be produced with the trigger and pump sprays, whereas small droplets can also be formed with aerosol spray devices using compressed gas or reduced levels of a propellant, such as, for example, butane.

How the invention may be put into practice will now be described in more detail in reference to the following Figures, in which:

Figure 1A is an illustration of a cross-sectional view taken through a portion of an example of a spray-through cap nozzle arrangement, in diagrammatic form;

Figure 1B is a further diagrammatical representation of a cross-section taken along line X-X' of Figure 1A;

Figure 2A is an illustration of a portion of the abutment surface of the lower part of a first embodiment of the present invention, in diagrammatic form;

Figure 2B is an end view showing the outlet orifice of the first embodiment of the present invention formed when the abutment surface of the lower part shown in figure 2A is brought into contact with an upper part of the nozzle arrangement to form the final assembled nozzle arrangement, in diagrammatic form;

Figure 3A is an illustration of a portion of the abutment surface of the lower part of a second embodiment of the present invention, in diagrammatic form;

Figure 3B is an end view showing the outlet orifice of the second embodiment of the present invention formed when the abutment surface of the lower part shown in figure 3A is brought into contact with an upper part of the nozzle arrangement to form the final assembled nozzle arrangement, in diagrammatic form;

Figure 4A is an illustration of a portion of the abutment surface of the lower part of a third embodiment of the present invention, in diagrammatic form;

Figure 4B is an end view showing the outlet orifice of the third embodiment of the present invention formed when the abutment surface of the lower part shown in Figure 4A is brought into contact with an upper part of the nozzle arrangement to form the final assembled nozzle arrangement, in diagrammatic form; and

Figure 5 is a diagrammatic illustration of a horizontal cross-section taken through a nozzle outlet arrangement of an embodiment of the present invention.

In the following description of the figures, like reference numerals are used to denote like or corresponding parts in different figures.

A portion of a conventional spray-though cap nozzle arrangement adapted to be fitted to a standard hand-held aerosol canister is shown in Figure 1A. The nozzle arrangement has a circular body 100 prepared from moulded plastic (only a portion of which is shown in Figure 1A). The underside of the body (not shown) is shaped to fit onto the end of a standard aerosol canister. Referring to both Figures 1A and 1B, it can be seen that the body 100 is composed of two separate parts, namely an upper part 101 and a lower part 102. The upper and lower parts have abutment surfaces 120a and 120b respectively, which are contacted together as shown in Figure 1B to form the functional nozzle arrangement. These abutment surfaces have grooves/recesses formed on their respective surfaces which, when contacted together, define an internally connected passage which extends from the outlet valve of the canister (not shown) to the outlet orifice 113 of the nozzle arrangement. In addition to the outlet orifice 113, the passage additionally comprises an inlet 110, a fluid flow passageway 111, and a swirl chamber 112 (all of which are shown in Figure 1A by hashed lines to indicate that these features are located internally within the nozzle arrangement when the upper part 102 and the lower part 103 are connected together). The inlet 110 is open to the fluid flow passageway 111. The fluid flow passageway extends towards the outlet orifice 113 and divides into two separate diverging branches 111a and 111b, respectively. The path of each diverging branch 111a and 111b turns though an angle of approximately 90° at 111c and 111d respectively, to form a connection with the channels 121a and 121b respectively. Channels 121a and 121b connect the branches of the fluid flow passageway to the swirl chamber 112.

As can clearly be seen in Figure 1B, the swirl chamber 112 has a circular cross-section and the channels 121a and 121b of the passage are open to the chamber and configured so that fluid entering the swirl chamber is caused to flow in a rotational or swirling manner. The outlet orifice 113 formed in the wall of the swirl chamber is circular in cross-section and is positioned centrally in the wall 114 of the swirl chamber 112 such that the central axis of the bore defined by the outlet orifice 113 aligns with the central axis of the swirl chamber 112 (shown diagrammatically as a hashed line in Figure 1B).

In addition, the upper part 102 is provided with a horseshoe-shaped protrusion 103 which fits into a correspondingly shaped groove 104 in the lower part 102 to create a seal between the upper and lower parts. This seal encircles around the inlet 110, the fluid flow passageway 111, the swirl chamber 112, and the fluid outlet orifice 113 and prevents fluid leaking from the fluid flow passage from seeping between the upper and lower parts and leaking out of the nozzle arrangement during use.

During use, an actuator portion of the nozzle arrangement (not shown) is pressed by an operator and this causes the actuator to engage with and open the outlet valve of the aerosol canister (not shown). The fluid ejected through the outlet valve enters the nozzle arrangement through the inlet 110. The fluid is then directed from the inlet 110 into the fluid flow passage 111 where the fluid stream is then split into two separate streams, one stream passing along the first branch 111a and the other stream passing along the second branch 111b. Each fluid stream is then diverted through approximately 90° at 113c and 113d respectively, into channels 121a and 121b where it is then directed into the swirl chamber 112. As shown in Figure 1B, the branches fluid flow passage 111a and 111b enter the swirl chamber in such a manner that the fluid streams are directed against the circular wall of the swirl chamber 112. This induces

rotational flow in the fluid stream prior to the ejection of the fluid droplets through the outlet orifice 113 in the form of a spray.

It shall be appreciated that the nozzle arrangement of the design shown in Figures 1A and 1B is not a typical example of a swirl chamber usually found in the art. Normally, a post butts against the swirl design, including the channels leading to the swirl chamber, and the fluid is directed around the post and into the channels.

A first embodiment of the present invention is shown diagrammatically in Figures 2A and 2B. For the purpose of illustration only, Figure 2A shows only the portion of the abutment of the lower part 102 of the nozzle which is encircled by the groove 103 that receives the groove 104 on the upper surface to form a seal. Likewise, Figure 2B is end view of the corresponding portion of the nozzle arrangement shown in Figure 2A, which is formed when the upper part 101 is brought into abutment with the lower part 102.

Referring to Figure 2A, the abutment surface of the lower part 102 has an inlet 110 and a grooved recess 211 which forms half of the fluid flow passageway 111 when aligned with a corresponding recess formed in the abutment surface of the upper part (not shown). A further recessed grove 211a also forms a first branch of the 111a of the fluid flow passageway when the abutment surfaces are brought into contact with each other. The groove 211a has a 90 degree turn at 111c where it connects to a channel 121a which connects the branch of the fluid flow passageway 111a to the swirl chamber 112, half of which is formed by a semi-circular recess 212 in the lower part 102. A further rectangular recess 201, which extends from the recess 212 to the external surface of the lower part 102 is also provided. This rectangular recess 201 aligns with a corresponding recess formed in the upper part 101 to form an elongate rectangular slit 202, as shown in Figure 2B. For the purpose of

illustration only, the swirl chamber 112, together with the channels 121a and a second channel 121b, which is connected to a second branch of the fluid flow passageway 111b formed in the upper part 101 (not shown), are also shown in Figure 2B.

Referring to Figure 2B, it can be seen that the slit 202 is positioned horizontally across the swirl chamber 112. In alternative embodiments, the slit may be positioned at any angle, such as vertically or diagonally.

Figures 3A and 3B show a second embodiment of a nozzle arrangement of the present invention. The second embodiment is identical to the first embodiment shown in Figures 2A and 2B, except that the external surface of the nozzle arrangement around the slit 202 is in the form of a dish-shaped recess 301. The slit is formed in the centre of the dish-shaped recess so that the external opening of the slit 202 has a curved profile. As previously discussed, this construction is preferred because an even cone spray is produced.

Figures 4A and 4B show a further embodiment of the present invention. Again, the embodiment shown in Figures 4A and 4B is exactly the same as that shown and described in reference to Figures 2A and 2B, except that instead of the slit 202 forming the outlet of the swirl chamber 112, three separate outlet orifices in the form of circular holes 401 are provided. In the embodiment shown, the holes are circular and are formed by the alignment of semi-circular recessed grooves formed in the abutment surfaces of the upper and lower parts, which extend from the swirl chamber to the external surface of the nozzle arrangement. The precise alignment of such grooves can be problematical. For this reason, it is usual to only form a groove in one of the parts, for example, the lower part, with the abutment surface of the other part providing a flat surface which forms a wall of the outlet orifice when the abutment surfaces of the upper and lower parts are contacted together.

In Figures 4A and 4B the outlet orifices are arranged in parallel. It is generally preferred, however, that the outlet orifices are arranged so that each orifice extends in a divergent direction from the swirl chamber, as shown in Figure 5.

Referring to Figure 5, the nozzle outlet arrangement 501 is intended to replace the outlet orifice 113 formed in the wall of the swirl chamber 112 shown in Figures 1A and 1B. The swirl chamber 112 receives fluid during use via a fluid flow passageway (not shown in Figure 5) in a similar manner to the arrangement described in reference to Figures 1A and 1B. The nozzle outlet arrangement 501 has four separate outlet orifices 510, 511, 512 and 513 arranged in a horizontal line, which also extends across the central longitudinal axis 502 of the swirl chamber 112. Each orifice defines a bore and the lines 520, 521, 522, and 523 show the central longitudinal axis of the bores of each of the orifices 510, 511, 512 and 513, respectively. The central longitudinal axis of each bore is disposed at a divergent angle with respect to the central longitudinal axis of the swirl chamber 502. More specifically, the central longitudinal axes of orifices 510 and 513 (shown by lines 520 and 523, respectively), are angled at 23° to the central longitudinal axis of the 502 of the swirl chamber and at 15° in relation to the central longitudinal axes of the orifices 511 and 512 respectively (shown by lines 521 and 522, respectively). The central longitudinal axes of orifices 511 and 512 (represented by lines 521 and 522 respectively) are angled at 8° to the central longitudinal axis 502 of the swirl chamber 112.

Therefore, during use, fluid droplets are ejected from the swirl chamber 112 along each respective bore and are thereby forced to diverge and generate four separate divergent sprays.

It shall be appreciated that the embodiments shown in the Figures are for the purpose of illustration only and should not be construed as a limitation of the scope of the present invention, which is defined in the appended claims.

CLAIMS

1. A nozzle arrangement adapted to be fitted to an outlet of a fluid supply and generate a spray of fluid dispensed through said outlet, said nozzle arrangement comprising an inlet through which fluid may access the nozzle arrangement from the from the fluid supply during use, a fluid flow passageway which connects said inlet to a swirl chamber such that fluid entering the nozzle arrangement during use is directed along said fluid flow passageway and into said swirl chamber, said swirl chamber being configured to induce rotational flow in the fluid passing through the nozzle arrangement, wherein said swirl chamber comprises at least two outlet orifices through which fluid can be ejected from the swirl chamber during use.

2. A nozzle arrangement adapted to be fitted to an outlet of a fluid supply and generate a spray of fluid dispensed through said outlet, said nozzle arrangement comprising an inlet through which fluid may access the nozzle arrangement from the from the fluid supply during use, a fluid flow passageway which connects said inlet to a swirl chamber such that fluid entering the nozzle arrangement during use is directed along said fluid flow passageway and into said swirl chamber, said swirl chamber being configured to induce rotational flow in the fluid passing through the nozzle arrangement, wherein said fluid outlet comprises a fluid outlet orifice in the form of an elongate slit opening.

3. A nozzle arrangement according to Claims 1 or 2, wherein said nozzle arrangement further comprises an actuator, the operation of which actuates the release of the fluid from the fluid supply.

4. A nozzle arrangement according to any one of the preceding claims, wherein said fluid supply is a pressurised fluid filled container.

5. A nozzle arrangement according to Claim 4, wherein said container is a an aerosol canister and the nozzle arrangement is adapted to be fitted to the

canister so as to enable the engagement of the actuator with the outlet valve of the canister, thereby enabling the release of the contents of the canister to be facilitated.

6. A nozzle arrangement according to Claim 3, wherein said fluid supply is a non-pressurised container having a pump or trigger nozzle device fitted to its outlet, whereby the operation of said pump or trigger actuates the release of the contents stored in the container.

7. A nozzle arrangement according to any one of Claims 1 or 3 to 6, wherein the swirl chamber comprises between 2 and 8 outlet orifices

8. A nozzle arrangement according to Claim 7, wherein the swirl chamber comprises two, three, four or five outlet orifices.

9. A nozzle arrangement according to any one of Claims 1 and 3 to 8, wherein each outlet orifice is arranged in a substantially parallel relationship so that any fluid passing through the orifices does so in a substantially parallel direction.

10. A nozzle arrangement according to Claim 9, wherein said outlet orifice defines a bore having a central longitudinal axis which is disposed in a parallel relationship with the central longitudinal axis of the swirl chamber.

11. A nozzle arrangement according to any one of Claims 1 and 3 to 8, wherein the outlet orifices are arranged in a divergent relationship so that the bore defined by each individual orifice is disposed at a divergent angle with respect to at least a proportion of the other outlet orifice present such that, during use, fluid passing through an outlet orifice does so in a divergent direction with respect to at least a proportion of the other outlet orifices.

12. A nozzle arrangement according to any one of Claims 1 and 3 to 11, wherein the external surface of each nozzle arrangement is shaped so as to form a dish or cone-shaped recess around the opening of each outlet orifice.

13. A nozzle arrangement according to any one of Claims 2 to 8, wherein the external surface of the nozzle arrangement may be shaped to form a dish-shaped or cone-shaped recess around the external opening of the slit.

14. A nozzle arrangement according to any one of Claims 2 to 8 and 13, wherein the width of the slit is up to 200 microns.

15. A nozzle arrangement according to Claim 14, wherein the width of the slit is up to 100 microns.

16. A nozzle arrangement according to any one of Claims 14 or 15, wherein said slit has a width dimension within the range of 20 to 60 microns.

17. A nozzle arrangement according to any one of Claims 2 to 8 and 13 to 16, wherein the elongate slit has a length within the range of 300 to 1300 microns.

18. A nozzle arrangement according to any preceding claim, wherein said nozzle arrangement is formed from at least two parts, each of said parts having an abutment surface which, when brought into contact with one another, define therebetween the inlet, fluid flow passageway, swirl chamber and outlet orifices of said nozzle arrangement.

19. A nozzle arrangement according to Claim 18, wherein in said at least two parts are releasably connectable so as to enable cleaning of the inlet, fluid flow passageway, swirl chamber and outlet orifices of said nozzle arrangement.

20. A nozzle outlet insert configured to be attached to, and form the outlet of, a nozzle arrangement comprising an inlet and a fluid flow passageway, said fluid flow passageway being adapted to connect said inlet to said insert such that, during use, fluid passing through said nozzle arrangement is directed from the inlet towards said insert along said fluid flow passageway, wherein said nozzle outlet insert comprises a swirl chamber having at least two outlet orifices formed therein.

21. A nozzle outlet insert configured to be attached to, and form the outlet of, a nozzle arrangement comprising an inlet and a fluid flow passageway, said fluid flow passageway being adapted to connect said inlet to said insert such that, during use, fluid passing through said nozzle arrangement is directed from the inlet towards said insert along said fluid flow passageway, wherein said nozzle outlet comprises a swirl chamber having an outlet orifice in the form of an elongate slit.

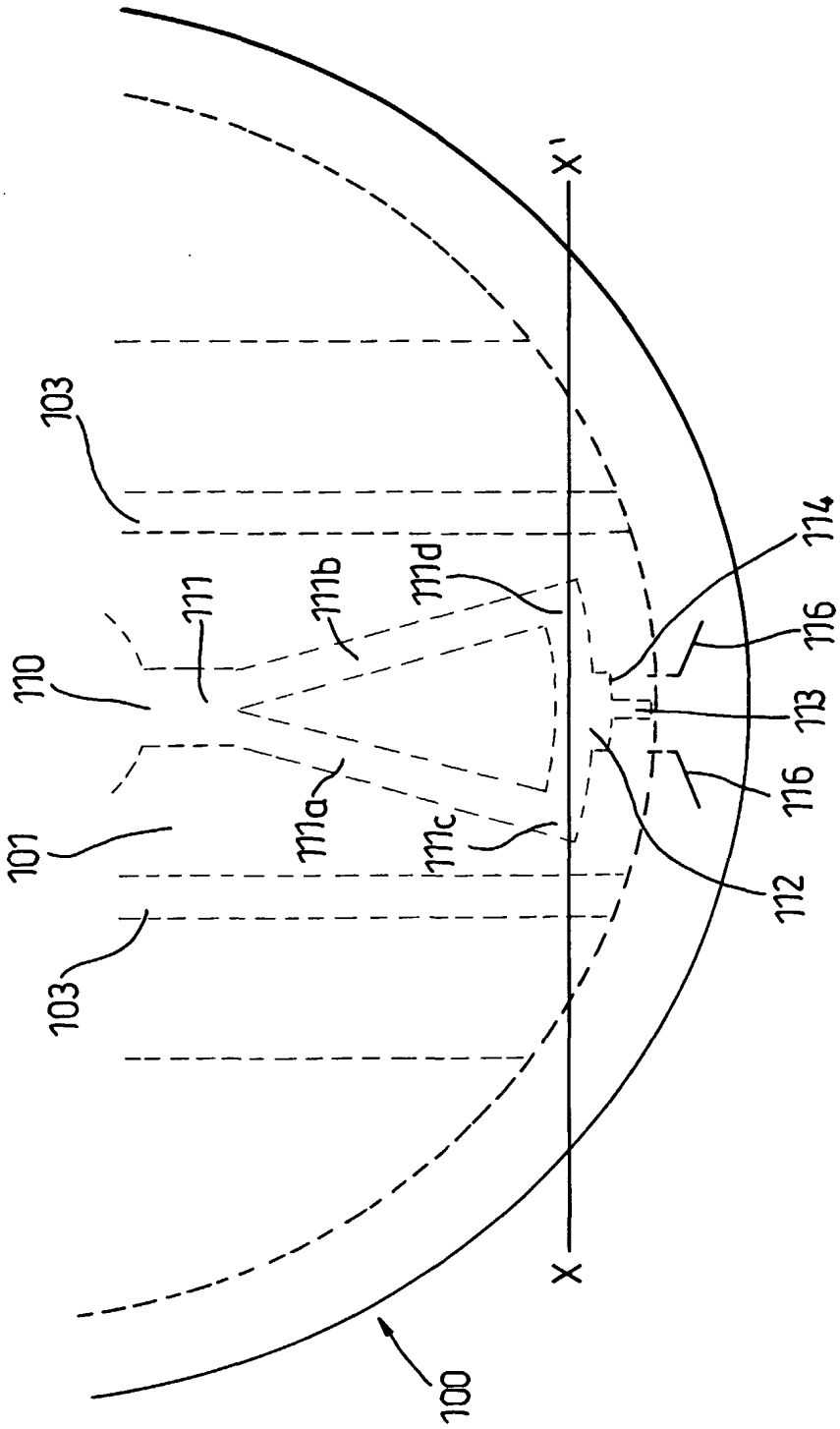
X'
X
100
101
103
103
110
111
111a
111b
111c
111d
112
113
114
116
116

Fig. 1A

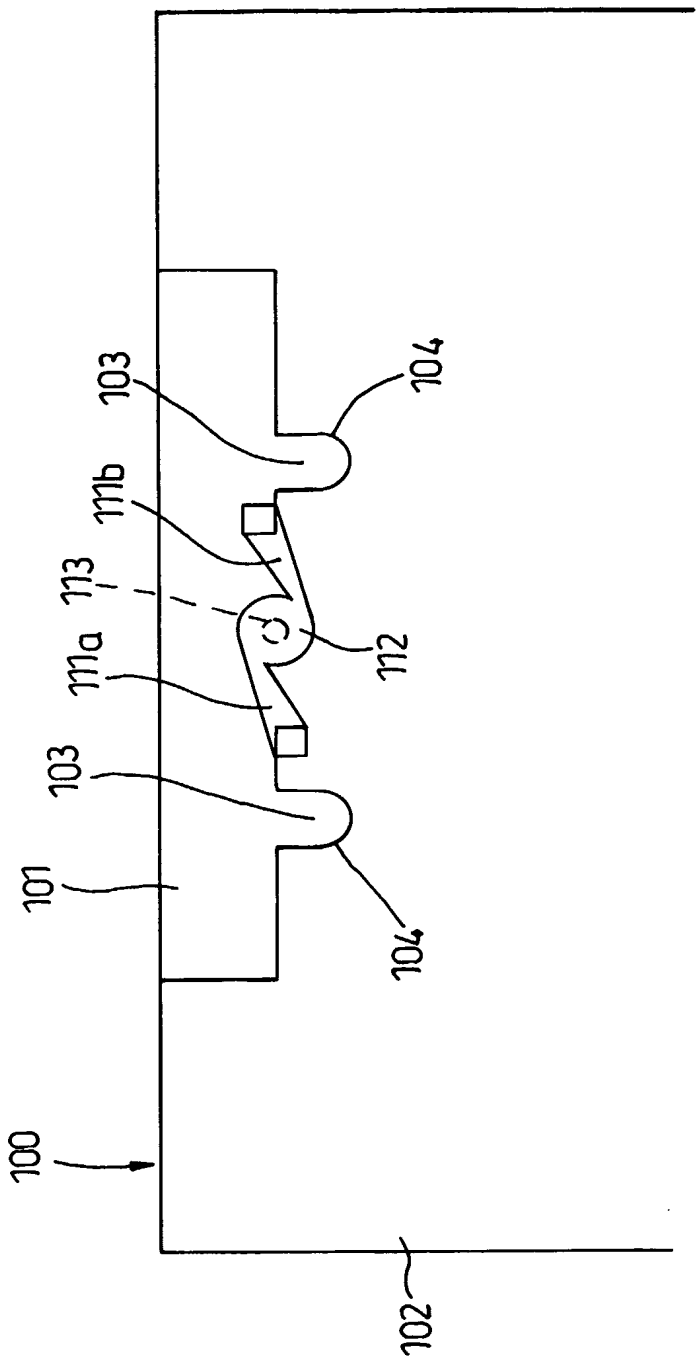

Fig. 1B

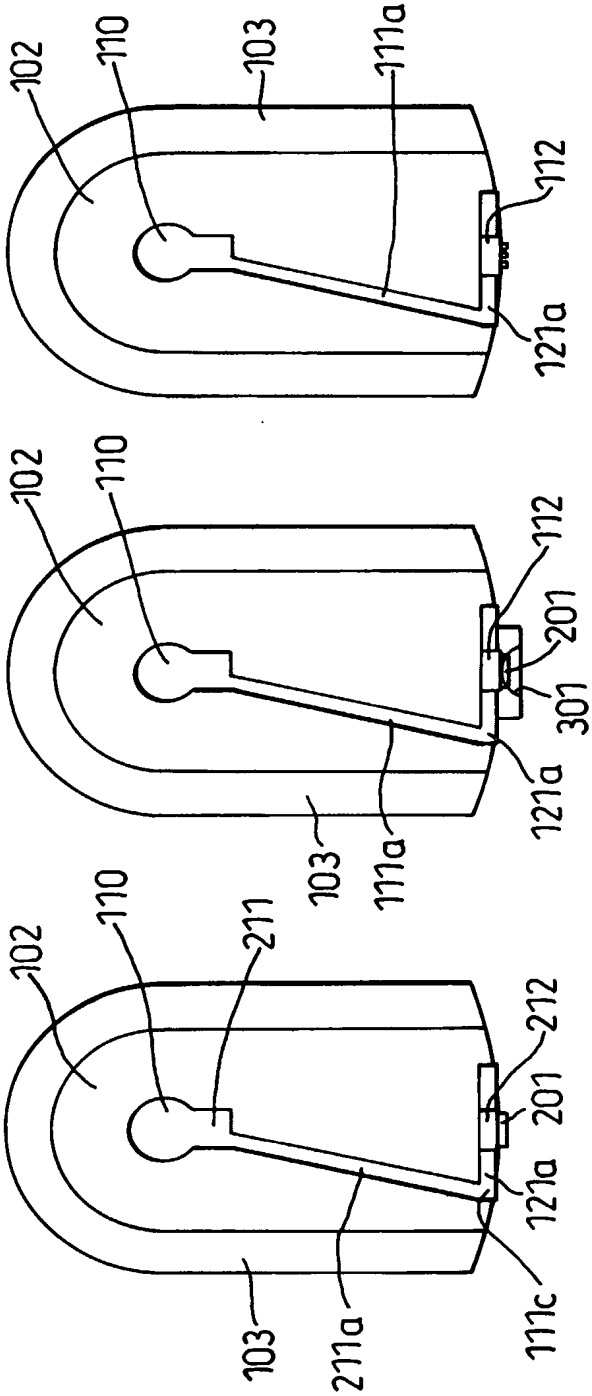

Fig. 2A

Fig. 3A

Fig. 4A

Fig. 2B

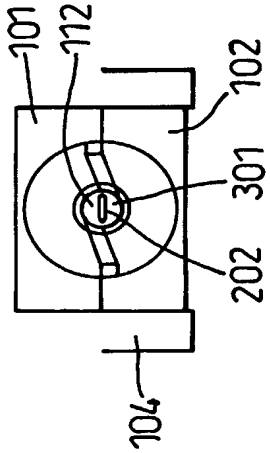

Fig. 3B

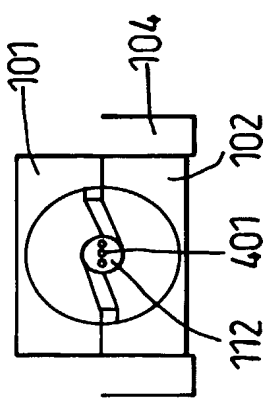

Fig. 4B

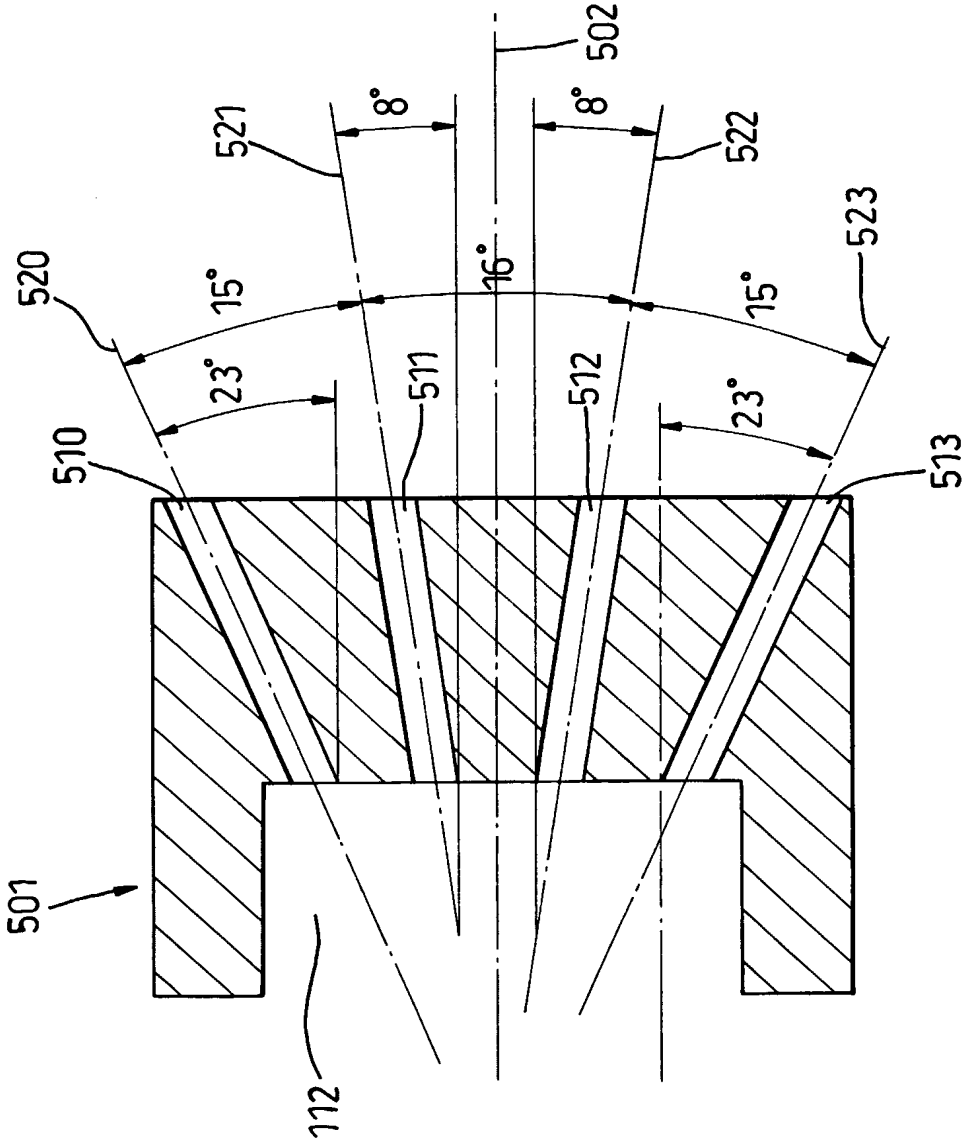

Fig. 5

INTERNATIONAL SEARCH REPORT

Internatic Application No
PCT/GB 02/05344

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B05B1/34 B05B1/14 B05B1/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 196 08 485 A (LINK EDMAR) 11 September 1997 (1997-09-11) column 2, line 59 -column 4, line 21; figures 1-12 ---	1,2,7,8, 11,20,21
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X	EP 0 439 109 A (TAPLAST S N C) 31 July 1991 (1991-07-31) column 4, line 27 -column 7, line 12; figures 1-8 --- -/--	1-3,7,8, 18-21

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 March 2003	02/04/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Daintith, E

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INTERNATIONAL SEARCH REPORT

Internatio[illegible] pplication No
PCT/GB 02/05344

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 036 112 A (HUNSICKER MICHAEL GREGGORY) 14 March 2000 (2000-03-14) column 4, line 48 -column 7, line 63; figures 1-4	1,3,6,7, 9,20
X	US 1 976 062 A (ESTEP MILES E) 9 October 1934 (1934-10-09) figures	2,21

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB 02/05344

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1, 3-12, 18-20

   A nozzle arrangement and a nozzle outlet insert for a nozzle arrangement having a swirl chamber with a plurality of outlet orifices

2. Claims: 2, 13-17, 21

   A nozzle arrangement and a nozzle outlet insert for a nozzle arrangement having a swirl chamber with an outlet orifice in the form of an elongate slit

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB 02/05344

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